

# Urban Landscape Evapotranspiration

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Irrigation controllers are now widely used to manage landscape irrigation; however, scientifically based information on when to apply water and how much to apply is limited. In California, the landscape industry is huge and there is increased competition among water users. Consequently, managing irrigations to optimize efficient water use is critically important to stretch existing water supplies. The University of California and California Department of Water Resources have developed an Excel program “LIMP.XLS” to help landscape professionals and homeowners to calculate  $ET_o$  rates, determine landscape coefficient ( $K_L$ ) values, estimate landscape evapotranspiration ( $ET_L$ ) and determine irrigation schedules. This program not only helps practitioners but it also clarifies what horticulturalists need to research to help to improve urban irrigation management.

Evapotranspiration from landscape vegetation is estimated using a regional measure of evaporative demand (i.e., reference evapotranspiration or  $ET_o$ ), a microclimate coefficient ( $K_m$ ) to adjust the  $ET_o$  for the “local” microclimate, a vegetation coefficient ( $K_v$ ) that accounts for the difference in ET between well watered vegetation and the local  $ET_o$ , a density coefficient ( $K_d$ ) that adjusts the ET estimate for plant density, a stress coefficient ( $K_s$ ) that adjusts for reductions in ET due to water stress and an evaporation coefficient ( $K_e$ ) that defines a baseline coefficient value. The landscape coefficient ( $K_L$ ) to estimate landscape ET ( $ET_L$ ) is estimated as

$$K_L = K_m \times K_v \times K_d \times K_s > K_e.$$

Then the landscape evapotranspiration ( $ET_L$ ) is computed as

$$ET_L = ET_o \times K_L.$$

The LIMP program calculates the regional daily mean  $ET_o$  rates by month using the regional mean climate data from CIMIS, which are input into a table in the program. Then the regional climate data are copied to a second table in the program and are modified to represent the local microclimate. The daily mean  $ET_o$  rates are again calculated for each month using the local microclimate data. The ratio of the local to the regional  $ET_o$  rates is used as the microclimate correction factor. The program also has the capability to adjust  $ET_o$  values for differences in slope and aspect of hills to determine the microclimate correction for undulating landscapes.

The vegetation  $K_v$  coefficient provides an adjustment for the difference in  $ET$  between the vegetation of interest and the reference surface assuming that the vegetation is well-watered with a full canopy. The  $K_v$  accounts for morphological and physiological differences between the vegetation and the reference surface ( $ET_o$ ).

Sparse canopies have lower  $ET$  than dense canopies of the same vegetation and a density coefficient ( $K_d$ ) is needed for the adjustment. The following correction for immature deciduous orchards is used to estimate  $K_d$ .

$$K_d = \sin\left(\frac{C_G}{70} \frac{\pi}{2}\right) \leq 1.0$$

where  $C_G$  is the percentage of ground covered by green growing vegetation.

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Many landscape species can experience water stress and still have a good appearance, so a landscape coefficient is used to adjust for reductions in  $ET_L$  due to stress. For example, Bermuda grass can be stressed more than Fescue grass, so a stress coefficient can be used to differentiate the  $ET_L$  of the two species. Monthly stress coefficient ( $K_s$ ) values are input into the LIMP program to adjust for water or salinity stress. A coefficient of  $K_s = 0$  would force  $ET_L = 0$  and a  $K_s = 1.0$  implies no reduction in  $ET_L$  due to water stress. After entering the monthly data, daily  $K_s$  values are computed for the entire year using a curve fitting technique.

The number-of-rainy-days per month (NRD) are input into the LIMP program, and it is used to estimate the rainfall frequency for each month. The rainfall frequency is used with  $ET_o$  to estimate bare soil evaporation ( $E_s$ ) using a 2-stage soil evaporation model. Then the bare-soil evaporation coefficient ( $K_e$ ) is estimated as  $E_s/ET_o$ .

The LIMP program outputs all coefficients and  $ET$  calculations for each day of the year. It also supplies information for irrigation scheduling in the worksheet RT. If the sprinkler system information is input, daily runtimes needed to replace the  $ET_L$  losses and account for application efficiency are calculated. There are also features to help develop and optimize irrigation schedules. The LIMP program is available free of charge from the web site <http://biomet.ucdavis.edu>.

